one or two, in which the problem could be discussed with abundant accuracy simply by the use of the geometric principle enunciated in text-books in dealing with the forms of the teeth of wheels.

The development of the moving picture and its mechanism, like that of many other inventions, has had to wait for, and has stimulated invention in relation to, its own elements or adjuncts. For instance, the early workers in moving-picture photography were met first by the insufficient sensitiveness of the photographic plate. The wet plate, with its silver bath, was, of course, hopeless; but the dry plate, with all its advantages of easy manipulation, has steadily improved in its requirements of light to make a good picture, until this has ceased to be a serious difficulty in a good light. However, the glass plate itself limited the number of pictures in a sequence to those that could be arranged in a spiral on a disc, and so was wholly inconsistent with the modern moving picture exhibition. The film, and with it the series of devices for sensitising, developing, fixing, washing, and perforating, had to be created before the moving picture as now understood could exist.

Two other questions discussed are those of colour kinematography, and living and speaking pictures. The explanation of the two methods of obtaining the three-colour components, the one by addition and the other by subtraction, is exceedingly clear, and this makes the discussion of the methods of different inventors the more luminous. Some stress is laid, and rightly so, on the Urban-Smith two-colour method, patented in 1902, which is the basis of the popular kinemacolour. The author does not state that this patent was the subject of an action which was hotly contested as far as the House of Lords, when a judgment was delivered which is of the most drastic kind in relation to ambiguity and confusion of language in a specification. This judgment is now constantly quoted, and is one which was much needed in consequence of the improper use of English patent protection, made more especially by American and German patentees. While there was no dishonest intention of this kind exhibited in the specification in question, there is no doubt that our Patent Office has been induced to allow patent specifications to be issued which are designed to mean anything in emergency, to the great advantage of the big bully; and, thanks to a kinemacolour specification, we now have in a judgment a cure so drastic as possibly to be more dangerous to the honest inventor than the disease.

In the speaking picture not only is the moving picture projected, possibly in colour, but the sounds heard at the time at which it was taken are reproduced also. When it is remembered how quick the eye and ear are to perceive want of synchronism, it will be realised what the mechanical difficulties are that must be surmounted in producing a successful speaking picture. Those who had the good fortune to be present at the Royal Institution when the Gaumont speaking pictures were exhibited in 1913 will remember how perfectly every element separately, and the whole conjointly, were produced. Of the colour effects the most astonishing were those of butterflies, with those brilliant iridescent blues and purples which would seem to defy imitation. However, after the photograph of those butterflies mounted on clockwork stands so as to revolve slowly had been shown, the originals on their stands were set revolving on the table, and it was seen that as far as the memory would serve the succession of iridescent hues, caused by the changing aspect of the wings, was identical in the original and in its presentation on the screen, and it appeared that Clerk Maxwell's three-colour theory of colour vision could not have a better proof of its sufficiency. However, the butterflies did not speak. Other pictures, one of a cock crowing, another of lions in a cage being annoyed by a bar of iron which was allowed to drop on to the stone floor, were each achievements of so perfect an order that, so far as the experience of the present writer goes, no moving picture had been so equable and free from flicker; no colour picture, whether moving or not, projected on the screen had approached these in faithful accuracy of colour; no gramophone—except, perhaps, the Autexophone of Parsons—had given so faithful a sound record; and the combination of the whole and the exact synchronism were such not only that the motion of the cock agreed with his voice, but the clink and ring of the iron exactly agreed with the moment at which it was seen to strike and bounce from the floor, while the lions were keeping up a snarl in consonance with their features. Where so much was attempted a failure in any part, and above all in the synchronism, would have converted the feeling of amazement and delight experienced by the audience into one of disgust at the obvious sham of the whole thing.

In addition to the list of patents to which reference has already been made, there is a bibliography covering the period from 1825 (Roget) to 1914 (Hallberg), and a list of British and foreign periodicals devoted to the subject.

C. V. BOYS.

MODERN ANALYSIS.

A Course of Modern Analysis. By Prof. E. T. Whittaker and Prof. G. N. Watson. Second edition, completely revised. Pp. 560. (Cambridge: At the University Press, 1915.) Price 18*s*. net.

THE treatise now under notice, which appears as a second edition of a former treatise by one of the authors, is in all essential respects a new work. Its scope has been extended in many directions, and very recent developments, of which a substantial number are due to the authors, receive a fair share of attention. The volume now gives a somewhat exhaustive account of the various ramifications of the subject, which are set out in an attractive manner. An unusually complete set of references is included, and the book should become indispensable, not only as a textbook for advanced students, but as a work of reference to those whose aim is to extend our knowledge of analysis. The references to original

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memoirs are conveniently arranged at the ends of the chapters.

Part i. is concerned with the processes of analysis. After an introduction to complex numbers, continuous functions, and the more fundamental theory of convergence and uniformity, the reader passes to the theory of Riemann integration. Analytic functions are then introduced, and an account of Cauchy's theory of residues is followed by the theory of the development of functions in various forms of infinite series. The chapter on asymptotic expansions and summable series is very compact, and in the ensuing chapter, on Fourier series, the authors have taken the bold course of treating these series by the elegant means of Cesàro's theory of summable series, instead of by Dirichlet's method. But as the theory of these series only appeals to the pure mathematician, who finds Dirichlet's method equally difficult, this course appears to be justified. Part i. concludes with a valuable chapter on integral equations, which, like those on the theory of integration and linear differential equations, is new.

Part ii. is devoted to the theory of the special transcendental functions, and commences with a very complete account of the Gamma function. The statement that this function was defined by Euler as an integral is slightly misleading; he obtained a limit of a product by interpolation from factorials, proved it equal to a Beta integral, and thence derived the Gamma integral. Possibly, however, the writers do not regard the product as being suitable for a definition, for it is not of Weierstrass's canonical form, and, indeed, it is difficult to show that it represents an analytic function. A sketch of the theory of the Zeta function of Riemann, from the point of view of analytic functions, is given, although an account of its applications to prime numbers seems to have been considered beyond the scope of the book. The work of Mellin and Barnes, which has appeared since the first edition, has enabled the authors to give a more brief and systematic account of the hypergeometric function and of its "confluent" form. As particular cases of these functions, the harmonics of the parabolic cylinder, and, of course, the Bessel functions, are considered in some detail. A chapter is devoted to the differential equations of mathematical physics, and a pleasing novelty is introduced into their treatment. The authors are successful in reducing to a minimum the labour inherent in a discussion of Mathieu's elliptic cylinder functions. The book concludes with three long and interesting chapters on elliptic functions, and it is pleasant to observe that Jacobi's notation for the Theta functions has been retained on account of its historical interest. Moreover, it is actually the most convenient of those in existence.

In matters of general arrangement the book is excellent throughout. Peano's system of paragraphing is adopted, and the reviewer can only express the hope that the system may become more universal. An appendix gives the essentials of the more elementary theory of simpler functions, and the index is noticeably complete. The examples are numerous and well selected from the point of view of the student who wishes to pursue the subject. But perhaps the most characteristic feature of the book is its success in giving rigorous proofs of theorems without relapsing into the dullness too often associated with rigour. In every respect it is worthy of the traditions of the Cambridge University Press.

DOCILITY AND OTHER DISEASES.

(1) *The Nemesis of Docility: A Study of German Character.* By E. Holmes. Pp. vii+264. (London: Constable and Co., Ltd., 1916.) Price 4*s*. 6*d*. net.

(2) *La Guerre et la Pensée Médicale.* By Prof. Ricardo Jorge. Pp. 63. (Lisbon, 1916.)

(1) BY docility the author means "readiness to obey for the sake of obeying, avidity for commands and instructions, reluctance to accept responsibility or exercise initiative, inability to react against the pressure of autocratic authority"; and this is what is wrong with Germany, where a slavishly docile majority is as wax in the hands of a dogmatic and domineering minority. The Germans lost their early domestic freedom in becoming feudalised, and they failed to recover it because of the disruptive influences of tribalism. The ultra-docility has grown and is obvious to-day alike in the Army, with its "serf-like rank-and-file" and its "arrogant, overbearing caste of officers," and in "an almost serf-like people," which bows to the despotism of the Kaiser, the Junker, and the lords of commerce and finance "as to the gracious rule of a divinely instituted 'State.'"

Having been Prussianised themselves, the Germans have sought solace in the dream of "forcibly Prussianising a greater Germany which would expand at last into a world-wide empire." They have also sought to make their dream come true. "The aggressive egoism of an over-docile people is the torch which has set the world ablaze." The blaze has given the world a glimpse of the pernicious way in which over-docility may deaden and brutalise a people. We wish it had left them less effective! That it will eventually betray Germany in the field is evidently the author's expectation, which we cannot but share. We wish again, however, that the symptoms of material Nemesis were a little more convincing than they are as yet, for the temporary success of the thoroughness of the ultra-docility which Mr. Holmes so vigorously damns remains as the active cause of incalculable wastage and misery, and as a terribly disquieting menace to civilisation.

While we are inclined to regard the author's survey as one-sided, and his interpretation in terms of the "ultra-docility" formula overstrained, we feel that he has powerfully presented part of the truth, and driven home the salutary moral: *Fas est et ab hoste doceri.*

(2) This is a beautifully printed lecture on "The War and Medical Thought," delivered in December, 1914, as a presidential address to the

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